DREDGED MATERIAL RESEARCH PROGRAM

TECHNICAL REPORT D-78-12

INVESTIGATION OF CONTAINMENT AREA DESIGN TO MAXIMIZE HYDRAULIC EFFICIENCY

by

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Final Report

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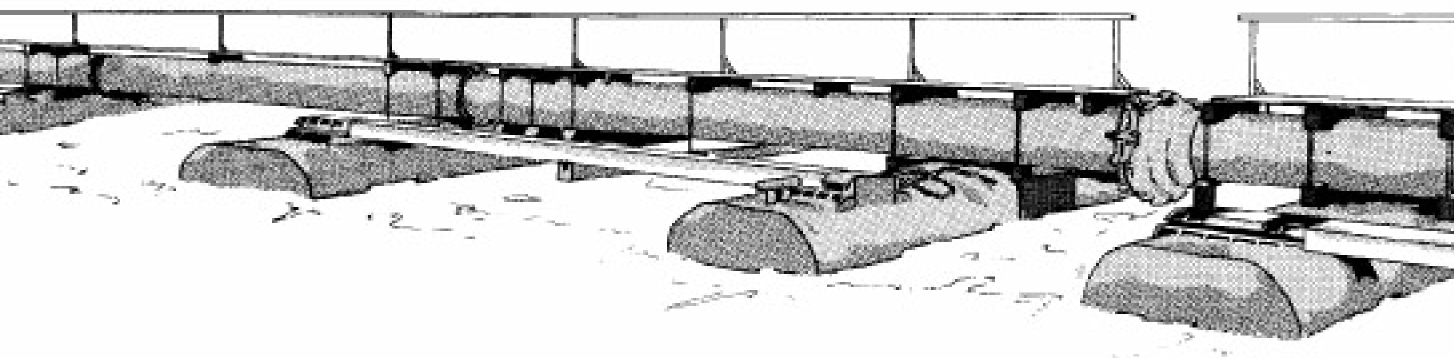

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SUBJECT: Transmittal of Technical Report D-78-12

TO: All Report Recipients

1. The report transmitted herewith represents the results of one of the research efforts (work units) initiated as part of Task 2C (Containment Area Operations) of the Corps of Engineers' Dredged Material Research Program (DMRP). Task 2C was included as part of the Disposal Operations Project, which among other considerations included research into the various ways of improving the efficiency and acceptability of facilities for confining dredged material on land.

2. Confining dredged material on land is a disposal alternative to which practically no specific design or construction improvement investigations (much less applied research) had been addressed prior to the DMRP. Being a form of waste-product disposal, dredged material placement on land has seldom been evaluated on other than purely economic grounds with emphasis nearly always on lowest possible cost. There has been a dramatic increase within the last few years in the amount of land disposal necessitated by confining dredged material classified as polluted. Attention necessarily is directed more and more to the environmental consequences of this disposal alternative and methods for minimizing adverse environmental impacts.

3. Several DMRP work units were conducted to investigate and improve facility design and construction and to investigate concepts for increasing facility capacities for both economic and environmental purposes. The study reported herein, conducted by Bryan J. Gallagher and Company, was conducted to investigate methodologies for improving the hydraulic efficiencies of dredged material containment areas and to develop general guidelines for the proper design and operation of containment areas in their inlet and outlet arrangements. The study consisted of:

a. A review of published literature and technical reports.

b. Site visits and field tests at 10 active disposal areas to obtain recent operational data.

c. Development of a mathematical model and computer programs to predict flow patterns and retention times for different containment area configurations.

d. Formulation of a general methodology for the design of efficient containment areas.

4. During the site visits and field tests, information on operational data, cost factors, effluent standards, existing guidelines, problem areas, and present and future needs concerning disposal area requirements was compiled through interviews with District personnel and on-site inspections, tests, and sampling. The range of settling effectiveness at all sites ranged from 88 to 99 percent solids removal. The settling performance data correlated reasonably well with the factors controlling retention time and demonstrated the importance of ponding water over dredged material in a containment basin. Dye-dispersion tests showed that short-circuiting and wind effects reduce the hydraulic efficiencies in open-water basins to 50 percent or less of hydraulic efficiency under typical conditions. Predicted retention-time distributions for these basins based on the hydraulic model were less than ideal plug-flow retention times but were considerably higher than actual measured times. This was attributed to strong wind effects. Wind-induced circulation was also determined on a theoretical basis to be a dominant factor.

5. It was concluded that the addition of spur dikes to increase the effective length-to-width ratio prevents short-circuiting between inlet and outlet, retards wind-induced circulation, and is the most economical method of maximizing hydraulic efficiency. Other recommendations include the specification of minimum ponding depths based on selected withdrawal principles and the design of long rectangular weirs to prevent flow concentrations and resuspension problems.

6. This study is but one of several studies addressing the problems of increasing the efficiency of containment areas. Guidelines presented herein should be considered interim with the final guidelines to be contained in a synthesis report on sizing and operating containment areas that is being developed from the results of this and the other related studies.

John L. Cannon
JOHN L. CANNON
Colonel, Corps of Engineers
Commander and Director

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This study was conducted to investigate methodologies for improving the hydraulic efficiencies of dredged material containment areas and to develop general guidelines for the proper design and operation of containment areas and their inlet and outlet arrangements. The study consisted of (a) a review of published literature and technical reports, (b) site visits and field tests at ten active disposal areas to obtain recent operational data, (c) development of a mathematical model and computer programs to predict flow

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20. ABSTRACT (Continued).

patterns and retention times of different containment area configurations, and (d) formulation of a general methodology for the design of efficient containment areas.

The sites visited were confined disposal areas with ongoing operations in the Baltimore, Charleston, Galveston, Mobile, Norfolk, Philadelphia, Portland, Savannah, Seattle, and Vicksburg Corps of Engineers Districts. Information on operational data, cost factors, effluent standards, existing guidelines, problem areas, and present and future needs concerning disposal requirements was compiled through interviews with District personnel and on-site inspections and sampling.

The range of settling effectiveness at all sites extended from 88 to 99 percent removal of solids. The settling performance data correlated reasonably well with the factors controlling retention time and demonstrated the importance of ponding water over dredged material in a containment basin. Dye-dispersion tests conducted at Yazoo City, Mississippi, showed that short-circuiting and wind effects reduce hydraulic efficiencies in open basins to 50 percent or less under typical conditions. Predicted retention-time distributions for these basins based on the hydraulic model were less than ideal plug flow retention times but considerably higher than actual measured times, and this was attributed to strong wind effects. Wind-induced circulation was also determined to be a dominant factor on a theoretical basis.

It was concluded that the addition of spur dikes to increase the effective length-to-width ratio, prevent short-circuiting between inlet and outlet, and retard wind-induced circulation was the most economical method of maximizing hydraulic efficiency, particularly for large, square-shaped areas. Other recommendations include the specification of minimum ponding depths based on selective withdrawal principles and the design of long, rectangular weirs to prevent flow concentration and resuspension problems.